PAPER AND RELATED PRODUCTS OF IMPROVED WET EXPANSION PROFILE

Field of the invention

The present invention relates to a web material containing cellulosic fibres, to casing paper based on such a web material and to casing material prepared from such casing paper and which is suitable for the packaging of sausage or other meat products or other food products.

Background to the invention

Paper and related cellulosic web-like products are generally produced by processes that include a drying stage. A wet cellulosic material always shrinks if it is dried without restraint, though the degree of shrinkage varies according to the nature of the material. During drying this natural shrinkage can be countered by the mechanical restraints developed due to the nature of the drying process used. When the drier is a single large glazed heated cylinder (commonly called a "Yankee" drier in the paper industry) the wet web is stuck to the surface of the cylinder and restraint is total, or substantially total, so that shrinkage across the web is minimal and uniform. In the case of a web dried unrestrained, for example in a hot air tunnel, shrinkage can be high but again is uniform.

Commonly, however, the drying stage is carried out by passing the web around a series of drying cylinders that are heated, usually by steam. Owing to the nature of the mechanical restraints on the web, primarily due to frictional forces, the degree of shrinkage that occurs in the web during the drying process varies across the width. The greatest shrinkage occurs at the edges of the web and the shrinkage gradually decreases towards the centre where it is at the minimum. The common multi-cylinder drier produces such an effect because restraint near the edges of the cylinders is low but at the centre it is high.

The degree of shrinkage that a cellulosic web undergoes during drying has a marked effect on several physical properties of the dried web, particularly the elongation and expansion characteristics. A significant effect is that when shrinkage is high the expansion of the web

on rewetting, termed "wet expansion", is high and when shrinkage is low wet expansion is low. Thus, the cross direction (CD) wet expansion profile of a multi-cylinder dried cellulosic web is of the same form as the shrinkage profile: high at the edges of the web and low at the centre. This type of profile is often termed a "smile".

A particular cellulosic web product for which wet expansion is a critical property is fibrous sausage casing base paper (casing paper). This material is normally manufactured from strong, relatively long vegetable fibres such as abaca and is impregnated with a viscose solution, which is thereafter regenerated, or a resin binder formulation such that the solids pick-up is, typically, 5%. This casing paper is then formed into tubes and impregnated with up to four times its own weight of cellulose solids from a viscose solution which is regenerated to form a sausage casing used for packaging meat products. Thus, the casing paper serves to reinforce the casing material which comprises the regenerated cellulose. The sausage casing will be filled (stuffed) with the meat product, usually in the form of a coarse paste, under pressure.

When the casing is used as a package for sausage or meat intended to be sliced to form a retail pre-pack it is particularly important that the casing tube expands consistently to the desired diameter so that when the sausage is sliced to a precise thickness, each slice is exactly the same weight and a given number of slices will be exactly the weight desired for the pre-pack. The degree of expansion of the casing at a given "stuffing pressure" is related to the wet expansion of the casing paper; a high expansion paper will give a tube with a relatively high expansion at stuffing pressure.

It is therefore a disadvantage of casing paper produced on a machine with multi-cylinder driers that the paper's wet expansion varies across the width and therefore the resultant casing's expansion at stuffing pressure varies according to the position across the machine of the paper from which it was produced.

A way of countering this disadvantage is to divide the width of the machine into regions of relatively low and relatively high wet expansion and to sell paper from these regions essentially as separate products with different wet expansion specifications. These products might be labelled, for example, as "edge cut" and "centre cut". The use of this

technique, while technically satisfactory, does give problems in the planning of casing paper production because the different "cuts" have to be balanced in the required volume; there is also the added complexity for the casing tube producer in the area of inventory control. It would seem that using the previously mentioned "Yankee" drier would overcome the problem but, because the web is dried under virtually total restraint, the expansion is too low and results in what is known as too "stiff" a casing. It has been suggested that a "through drier" would overcome the profile problem (see U.S. Patent No. 3 822 182); such a drier does create a more uniform profile but again, because of the comparatively high drying restraint, the product lacks elongation. There is hence still a need in the art for a casing paper with a reduced CD wet expansion profile but which can be produced whilst still using a multi-cylinder drying regime and thus retaining the advantages of that method.

Summary of the invention

It has now been found that improvements in the CD wet expansion profile can be achieved by the forming of a cellulosic web, e.g. one made primarily from abaca fibres, into which there is incorporated synthetic fibres, typically polyester, generally in a relatively small quantity. Preferably the cellulosic web is a wetlaid web.

Thus, in one aspect, the present invention provides a web material comprising cellulosic fibres and synthetic fibres; in a second aspect the present invention provides a process, preferably a wetlaying process, for producing such a web material.

In another aspect, the present invention provides the use, in a web material comprising cellulosic fibres, of synthetic fibres for reducing variations in wet expansion in the cross direction of the web material.

In yet another aspect, the present invention provides a casing paper, suitable for the preparation of casing material for the packaging of sausage or other meat product, which casing paper contains a web material comprising cellulosic fibres and synthetic fibres, the web material being bonded with regenerated cellulose or with a resin binder or mixture of resin binders.

In a further aspect, the present invention provides a process for preparing casing paper which comprises forming, preferably by wet-laying, a web containing cellulose fibres and synthetic fibres, and impregnating the web with a resin binder, or mixture of resin binders, or with viscose.

In yet a further aspect, the present invention provides a casing material for the packaging of sausage or other meat product, which comprises material, e.g. in the form of a sheet or a tube, comprising regenerated cellulose in which there is embedded a casing paper according to this invention or a casing paper prepared by a process according to this invention.

In the fourth and sixth aspects of the present invention indicated above, the synthetic fibres are selected from (i) fibres made of an organic polymer selected from polyesters, polyamides, polyolefins and copolymers thereof, (ii) fibres made of a mixture of such organic polymers and (iii) mixtures of fibres (i) and/or (ii). Such synthetic fibres are suitable in the other aspects.

Brief description of the drawing

The accompanying figure is a graphical representation of the variation of wet expansion along the CD (i) of an exemplary sample of casing paper having a basis weight (grammage) of 21 m^2/g and (ii) of, for comparison, a standard casing paper of similar basis weight.

Description of exemplary embodiments

The cellulosic fibres are generally vegetable fibres, preferably long vegetable fibres, such as long, lightweight nonhydrated fibres of the Musa type. Typically, the average fibre lengths will be from 4 to 15 mm but the presence of shorter or longer fibres is not precluded. Exemplary vegetable fibres are sisal, flax, jute or preferably, abaca. However, the cellulosic web may also comprise woodpulp fibres, typically in an amount of up to 50% by weight of the total fibre content.

The synthetic fibres are generally of a man-made organic polymer or mixture of man-made organic polymers, e.g. polyesters (e.g. polyethylene terephthalate), polyamides (e.g. poly(hexamethylene adipamide) or polycaproamide, or nylon) or polyolefins (e.g. polyethylene or polypropylene). Fibres made of copolymers also come into consideration. A mixture of two or more types of synthetic fibre may, of course, be used.

Preferred synthetic fibres have a high wet modulus. Synthetic fibres having a low melting point, e.g. polypropylene, will generally not be used when the casing material has to be exposed to high temperatures, as when sausage packaged therein is cooked.

The synthetic fibres preferably have an average fibre length of 2 to 20 mm, more preferably 5 to 12 mm. They preferably have a linear density of 0.5 to 6.7 dtex, more preferably 1.7 to 5 dtex.

The proportion of synthetic fibres in the web need not be high and will generally be in the range of from 0.5 to 20% by weight of the total fibre content. To maintain other strength characteristics at high values it is preferred to employ the synthetic fibre at a level of no more than 10% by weight, although the level is preferably at least 1%. A content of synthetic fibre of from 3 to 9% by weight of total fibre content in the web is particularly preferred. The synthetic fibre should in general be uniformly or substantially uniformly distributed in the web.

Methods for producing cellulosic webs suitable for use as casing paper are known in the art and can be readily adapted to the present invention by the incorporation into the fibre furnish of the required proportion of synthetic fibre. Wetlaying methods of web formation are preferred but in principle dry-laid, e.g. air-laid, webs can be used in the practice of this invention.

The web may also be produced as a two-phase material in which the two phases each contain both the cellulosic (especially natural cellulosic) fibres and the synthetic fibres but in different proportions. The proportions for the total web, however, are preferably within the ranges specified above. This embodiment permits the production of casing paper that has a high level of synthetic, e.g. polyester, fibre on one face. Methods of producing two-phase webs are known – see US-A-2 414 833, US-A-4 460 643, GB-A-1542575 and WO-A-97/04956, the teaching in each of which is incorporated herein by reference – and can be readily adopted for the production of two-phase webs according to the present invention.

After formation the web may (if appropriate) be dried, at least partially and preferably substantially fully, and thereafter, impregnated with a viscose solution, dried and the viscose regenerated with dilute acid, normally sulfuric acid, washed and dried. For example, the paper web may be saturated with a dilute viscose solution, for example a solution obtained by diluting a solution containing 7% by weight of cellulose (as cellulose xanthate) and 6% by weight of sodium hydroxide to 1% cellulose content. The resultant viscose-saturated web is then dried and the cellulose in the viscose may then be regenerated by passing the web through an acidic regenerating bath containing, for example, a 1 to 8% aqueous sulfuric acid solution. The web may then be washed free of acid and dried in order to produce a paper web impregnated with acid-regenerated cellulose. This casing paper is then generally formed into rolls ("master rolls").

Alternatively, after formation the web may (if appropriate) be dried, at least partially and preferably substantially fully, and thereafter treated with a resin based binder and dried (once more). The binder may, of course, be a formulation comprising two or more components. For example, US-A-3,484,256 discloses a process for the production of casing paper in which a fibrous web is bonded with a cationic thermosetting resin and a polyacrylamide resin. Another example of a resin-based binder formulation is disclosed in GB-A-1,536,216, according to which casing paper may be made by treating the fibres of a fibrous paper web with a water-soluble cationic, thermosetting, epihalohydrin-containing resin (e.g. a polyamide-epichlorohydrin or polyamine-polyamide-epichlorohydrin resin, for example Kymene 557, ex Hercules), a non-viscose film-forming material (e.g. a cellulose ether such as hydroxyethyl cellulose, methyl cellulose, hydroxypropyl cellulose or sodium carboxymethyl cellulose, polyvinyl alcohol, starch, starch derivatives or natural gums) and a polyalkylene imine, for example polyethylene imine. Yet another possibility is the binder system disclosed in US-A-5,300,319, according to which a fibrous base web is compressed and then treated with a solution of a non-viscose bonding agent, in particular a bonding agent selected from polyvinyl alcohol, chitins (especially de-acetylated chitins), polyacrylamides, alginates, cellulose based materials (such as carboxymethyl cellulose, methyl cellulose, hydroxyethyl cellulose, hydroxypropylmethyl cellulose or hydroxypropyl cellulose), cationic starches, anionic starches, acrylic latexes, modified proteins, vinyl acetate ethylene emulsions and vinyl acrylic emulsions. In EP-A-0,369,337, a sausage

casing is described which contains a cellulose fibre mat sized with cellulose aminomethanate.

The drying in all cases can be carried out on multi-cylinder steam heated driers. The product from this process, which would have low variation of wet expansion in the CD, could be used as a fibrous base for a viscose based sausage or meat casing. Thus, for example, casings for the packaging of processed meats, e.g. sausage, may be manufactured from the casing paper by cutting it into strips which are then folded to form tubes. The tubes may be saturated with an alkaline viscose solution, e.g. one containing 7% by weight of cellulose and 6% by weight of sodium hydroxide. The cellulose in the viscose may then be regenerated by means of an acidic regenerating bath containing, for example, dilute sulfuric acid and possibly such salts as sodium sulfate or ammonium sulfate. The tube is then passed through one or more baths in order to wash out the acid and the salts. If desired, the tube may be passed through an aqueous bath which contains a plasticizer, e.g. glycerine, for the regenerated cellulose. The tube may then be dried by passing it through a heated chamber (the tube being in an inflated state) to give a cellulosic tubing which has embedded therein a paper web. This tubing may then be stuffed with a processed meat product under pressure. A process of this type is described in detail in US-A-3,135,613. A process in which the inner wall of a tubular regenerated cellulosic casing is treated with a cationic thermosetting resin is disclosed in US-A-3,378,379.

The teaching in each of the aforesaid US Patents, in the aforesaid European Patent Application and in the aforesaid British Patent is incorporated herein by reference.

A web of this invention could also be envisioned as having application in other end uses requiring relatively uniform wet expansion at different positions across the web. In such application, different cellulosic fibres may be used, the impregnants might be different or might be omitted or different forms of treatment might be employed.

Although the Applicant does not wish to be bound by theory, it is postulated that the synthetic fibres in the web, are much less susceptible to dimension changes on wetting or drying than cellulosics and this greater dimensional stability is transferred to the web as a whole and results in a lessening of the difference in shrinkage and regrowth behaviour of

the web edges compared to the web centre. It has also been found that webs prepared according to the present invention can exhibit low variation in CD wet expansion whilst retaining adequate expansion for sausage-stuffing and like operations. This avoidance of "stiffness" is an additional advantage in certain applications.

The present invention is further illustrated in and by the following Examples.

Examples

In Examples 1 to 3, casing paper has been produced using a conventional wetlaid inclined wire forming process from 100% abaca fibre on the one hand and 94% abaca fibre and 6% 3.3 dtex, 6 mm precision cut polyester fibre on the other hand. The polyester was available under the trade name "Grillon NV2". All fibre webs have been treated with viscose solution so as to achieve a 5% cellulose pick-up and the viscose has then been regenerated with dilute sulphuric acid and washed so as to achieve a final product pH of about 4.9. Three drying stages were employed: after wet-laying, after viscose saturation, and after the regeneration step.

The test methods used in Examples 1 to 4 were:

- Grammage: ISO 536 using a sample size 203 mm (8 inches) square.
- Tensile strength: ISO 1924-2.
- Wet Mullen bursting strength: ISO 3689 except that the soaking time is one minute.
- Wet expansion:

  A constant rate of extension tensile tester (such as would be used for ISO 1924-2) was set up for the following test conditions:

  Test speed = 25.4 mm/min. (1 inch/min.)

  Gauge length = 127 mm (5 inches)

  Pre-load = 0.

  A 25.4 mm (1 inch) sample strip was clamped in the jaws, the tester was started and stopped when the load was between 0.02 and 0.04 N. Three or four bursts of deionised water were sprayed onto the sample from a hand sprayer in order to soak the sample. The tester was restarted and the wet expansion was read off as the elongation when the load was at 0.1 N.

Wet expansion is expressed as a percentage of the gauge length (sample length before the test was started).

In the data tables, the wet expansion at the centre and the edge are given. Each of these measures was taken at two preset positions across the width. Also included is the maximum to minimum range (in absolute %) of a cross machine profile measured at 16 equally spaced positions.

Test data for the examples are tabulated below:

Example 1 (2 tests of the invention): target grammage 21 g/m^2

Property	100% abaca	94% abaca, 6% polyester	
	Standard	Test 1	Test 2
Grammage (g/m^2)	20.84	21.29	21.56
MD tensile strength (N/m)	1841	1682	1768
CD tensile strength (N/m)	1235	1025	1112
Wet burst (Kpa)	42	47	43
CD wet expansion, centre (%)	1.35	1.18	0.93
CD wet expansion, edge (%)	2.22	1.86	1.57
CD wet expansion range, 16 positions (%)	1.5	1.07	0.68

Figure 1 shows the 16 position profiles of CD wet expansion for the standard material and the material of Test 1.

Example 2: target grammage 19 g/m^2

Property	100% abaca	94% abaca, 6% polyester
Grammage (g/m^2)	19.03	19.1
MD tensile strength (N/m)	1667	1474
CD tensile strength (N/m)	1006	898
Wet burst (Kpa)	48	34
CD wet expansion, centre (%)	1.58	1.19
CD wet expansion, edge (%)	2.7	1.8
CD wet expansion range, 16 positions (%)	1.28	0.82

Example 3: target grammage 17 g/m^2

Property	100% abaca	94% abaca, 6% polyester
Grammage (g/m^2)	17.05	17.31
MD tensile strength (N/m)	1338	1248
CD tensile strength (N/m)	908	765
Wet burst (Kpa)	38	34
CD wet expansion, centre (%)	1.4	1.02
CD wet expansion, edge (%)	2.54	1.55
CD wet expansion range, 16 positions (%)	1.55	0.84

All the examples show that material produced by the method of the invention has a reduced absolute CD wet expansion but the difference between the highest and lowest values by both methods of measurement is significantly reduced. Though there has been a reduction in the absolute value of wet expansion in these examples, it is still possible to control this by control of the degree of stretch applied to the paper during drying. Though these levels of stretch (often termed "draw") cannot be quantified, a comparison of Tests 1 and 2 of Example 1 illustrates that wet expansion level can be controlled. The material of

the invention also has a reduced tensile strength but the wet bursting strength does not show a significant change.

Example 4: target grammage 21g/m^2

In this example casing paper has been produced using the resin impregnation process of US-A-5,300,319. Two drying stages were employed: after wet-laying and after the impregnation with resin.

Property	100% abaca	94% abaca, 6% polyester
MD tensile strength (N/m)	1835	1699
CD wet expansion, mean (%)	1.5	0.96
CD wet expansion range, 16 positions (%)	1.36	1

Example 5:

Casing paper manufactured according to Example 2 was formed into casing tubes with a nominal diameter of 70 mm. The diameter of the tubes was then measured when the internal pressure was 21 kPa. For casing paper taken from the centre of the machine which has a CD wet expansion of 0.9%, the diameter under pressure was 76.5 mm; for paper taken from the edge of the machine which had a CD wet expansion of 1.3%, the diameter under pressure was 77.2 mm. (The CD wet expansion values in this Example were measured by a slightly different method to that used in Example 2: this, coupled with sampling differences, may explain the differences between the values quoted in this Example and those quoted in Example 2.) For a 70 mm nominal diameter casing tube the diameter tolerance under pressure is 74.6 mm to 77.6 mm so that paper from any part of the paper machine could have been used to produce this size of casing. If paper made by the prior art method had been used then paper from the edge of the machine would have been outside the tolerance. It should be noted that paper made according to the prior art with a CD wet expansion as low as 0.9% would produce casings with a diameter under pressure below the lower tolerance limit; the paper of the invention is not as "stiff" as the prior art material.

It will, of course, be understood that the present invention has been described above purely by way of example and that modifications of detail can be made within the scope of the invention.

5